Claims

1. Method for precipitating mineral particles on fibres to be used for manufacturing paper, paperboard or the like, which method comprises at least the following steps:

(a) a fibre material containing the fibres to be used in manufacturing is fed into a precipitation reactor;

(b) a reactive mineral substance, such as calcium hydroxide ($Ca(OH)_2$), is fed into the precipitation reactor;

(c) the reactive mineral substance and fibre material are mixed to form a fibre suspension in the precipitation reactor and/or before these substances are fed into the precipitation reactor;

(d) the fibre suspension in the precipitation reactor is exposed to a substance which precipitates at least partially the said reactive mineral substance, in which case at least part of the precipitated mineral substance thus formed precipitates on fibres residing in the fibre suspension, and

(e) the thus treated fibre suspension is led out of the precipitation reactor, characterised in that

(f) a gas, which contains a substance precipitating the said reactive mineral substance, such as carbon dioxide (CO_2), is fed into the precipitation reactor, for forming a gas space containing the said precipitant in the precipitation reactor, and that

(g) the fibre suspension that has been fed and/or that is formed in the precipitation reactor is disintegrated as small solid particles or liquid drops and/or particles into the said gas space.

2. Method according to claim 1, characterised in that

in stage (g) the liquid phase of the fibre suspension is disintegrated as small liquid drops, which are predominantly < 10 mm, typically < 1 mm, into the gas space.

3. Method according to claim 1, characterised in that

forces are targeted at the fibre suspension in an activation zone, located in front of the precipitation reactor or at the beginning of the precipitation reactor with regard to fibre suspension flow, said forces activating the fibres so that the ability of the

fibres to bind with each other, and to bind precipitating and/or precipitated mineral substance, increases.

4. Method according to claim 3, characterised in that
in order to promote activation, forces such as recurrent impacts, double impacts, shear forces, turbulence, over- and underpressure pulses or other corresponding forces are directed into the fibre suspension, whereby
- the fibres are mechanically activated, especially their surfaces, by fibrillating or refining the fibres and opening their lumens for mineral substances, for example, and/or
- the fibre surfaces are chemically activated, for example, forming active OH^--groups on the fibre surfaces.

5. Method according to claim 3, characterised in that the fibre suspension flow running through the activation zone is subjected to sequential strong impacts and double impacts, which are generated in the fibre suspension flow using blades or the like rotating at a speed of 5 - 250 m/s.

6. Method according to claim 3, characterised in that
the activation zone of the precipitation reactor comprises a through-flow mixer operating on the principle of an impact mill, having several, typically 3 - 8, more typically 4 - 6 coaxially arranged rings equipped with blades, of which at least every other ring operates as a rotor, and the adjacent rings of these rings as stators or rotors, and in which the difference in speed between the rotors and the stators and rotors of adjacent rings is 10 - 500 m/s, typically 50 - 200 m/s,
- the fibre suspension is supplied so as to move from the centre of the through-flow mixer radially outwards through its rings, in which case the blades on the rings direct recurrent impacts, double impacts, shear forces and/or over- and underpressure pulses on the fibre suspension flowing outwards, which all together activate the fibres.

7. Method according to claim 6, characterised in that
at least part of the gas to be fed into the precipitation reactor, containing a substance precipitating the mineral substance, is fed to the precipitation reactor through the

activation zone, in which case the fibres activated in this activation zone come into contact with the said precipitant immediately during activation or right after it.

8. Method according to claims 3-7, characterised in that the dwell-time of the fibre suspension containing the fibre material and the reactive mineral substance in the activation zone is short, < 10 s, typically < 2 s, more typically < 1 s.

9. Method according to claim 1, characterised in that
gas containing > 5 %, typically > 10 %, of precipitant, such as carbon dioxid, is fed into the precipitation reactor.

10. Method according to claim 1, characterised in that
- gas containing the precipitant is pure or nearly pure carbon dioxide, combustion gas or other carbon dioxide-containing gas, or any gas suitable for precipitating the used reactive mineral substance, or is a mixture of these gases, and that
- gas containing the precipitant is fed into the precipitation reactor so that overpressure is maintained in the precipitation reactor.

11. Method according to claim 1, characterised in that
- the fibre suspension is led through two or several precipitation reactors wherein the gas composition of the gas spaces may be different, for example, so that
- the gas containing the precipitant in the first precipitation reactor is pure or nearly pure carbon dioxide, and in the next precipitation reactor or in the one after that the gas is a combustion gas or another gas less rich in carbon dioxide content, or that
- the gas containing the precipitant in the first reactor(s) is less rich in carbon dioxide content, and in the next precipitation reactor or in the next after that, the gas is pure or nearly pure carbon dioxide.

12. Method according to claim 1, characterised in that
- the reactive mineral substance consists of calcium hydroxide, calcium sulphate, calcium oxide or other reactive mineral substance and/or their mixture, which is suitable to be precipitated with a precipitant, and
- the reactive mineral substance is selected so that the product to be manufactured from fibres is brought the desired characteristics, for example, the desired optical characteristics.

13. Method according to claim 1, characterised in that the fibre material comprises
- virgin fibre obtained from chemical, mechanical, chemi-mechanical, thermo-mechanical or corresponding process;
- de-inked or inked recycled fibre obtained from newsprint, kraft paper, soft paper, special paper or paper board, or fibre obtained from broken or other corresponding fibre,
- bleached or unbleached fibre, refined or unrefined fibre, dried or undried fibre, or any mixture of any of these.

14. Method according to claim 1, characterised in that fibre material contains fibres, in addition to fine matter such as fibre based fine matter, impurities and/or mineral substances.

15. A method according to claim 1, characterised in that fibre material is fed into the precipitation reactor at a thickness of 0.1 – 40%, more typically 1 – 15%, most typically 3 – 7 %.

16. An apparatus for precipitating mineral particles to fibres to be used in manufacturing paper, paperboard or the like, said apparatus comprising a precipitation reactor equipped with
- feeding devices for supplying fibre material and mineral substances, either separately or together as a fibre suspension, to the precipitation reactor;
- feeding devices for supplying gas, containing a substance precipitating the mineral substance, to the precipitation reactor;
- a precipitation space, in which the fibre material and fibre suspension containing the reactive mineral substance, fed into the precipitation reactor, are brought into contact with the gas containing the said precipitant, and
- devices for discharging the fibre suspension containing the fibre material and precipitated mineral substances from the precipitation reactor, characterised in that the precipitation space comprises a gas space, in which the fibre suspension containing the fibre material and reactive mineral substances are brought in contact with the gas containing the said precipitant, and
- the precipitation reactor also comprises disintegration devices for disintegrating the fibre suspension, containing the fibre material and reactive mineral substances,

fed to the precipitation reactor, as small solid particles or liquid fractions such as drops and/or particles, into the said gas space.

17. Apparatus according to claim 16, characterised in that the disintegration devices comprises a through-flow mixer, operating on the principle of an impact mill, which comprises several, typically 3 - 8, more typically 4 - 6, coaxial rings equipped with blades, of which at least every other ring operates as a rotor, and the adjacent rings of these rings either as a stators or rotors, and that in the through-flow mixer

- the difference in speed of the said rotors, and the stators or rotors of adjacent rings is 10 - 500 m/s, typically 50 - 200 m/s, and
- the blades on the rings are disposed so that the fibre suspension flowing mainly radially outward is subjected to recurrent impacts, double impacts, shear forces, turbulence, and/or over- and underpressure pulses which activate the fibres.

18. Apparatus according to claim 17, characterised in that

- the feeding devices for supplying the fibre material and reactive mineral substance to the precipitation reactor are arranged so that these substances are fed predominantly in to the centre of the rings of the through-flow mixer, and
- the feeding devices for supplying the gas containing a substance precipitating the mineral substance, is arranged so that the gas is fed mostly to the through-flow mixer, allowing the precipitation to begin already in the through-flow mixer.

19. Apparatus according to claim 18, characterised in that

- the through-flow mixer is fitted in the top section of the gas space in the precipitation reactor,
- the through-flow mixer has predominantly an open outermost ring which allows the fibre suspension having flowed through the through-flow mixer to be discharged from rings to different directions and
- devices for removing the fibre suspension containing the fibre material and precipitated mineral substance from the precipitation reactor is arranged at the bottom section of the precipitation reactor.

20. Apparatus according to claim 17, characterised in that

one or several discharge openings have been arranged on the outermost ring of the

through-flow mixer for removing the fibre suspension having flowed through the through-flow mixer from the precipitation reactor.

21. Apparatus according to claim 16, characterised in that
the device comprises at least two sequentially connected precipitation reactors equipped with through-flow mixers.

22. Apparatus according to claim 16, characterised in that
the device comprises a through-flow mixer, operating on the principle of an impact mill, which is fitted in front of the precipitation reactor, and is arranged to process fibre material or fibre suspension containing the fibre material and reactive mineral substance to be fed to the precipitation reactor, so as to activate the fibre material before it is fed to the precipitation reactor.

23. A method for pretreating the fibre material used in manufacturing paper, paperboard or the like for activating the fibres and their surfaces, for example, so that their ability to bind with each other either mechanically or chemically increases, their ability to bind mineral substances either mechanically or chemically increases, active OH-groups are formed on their surfaces and/or their lumen opens up to allow mineral substances to precipitate inside the fibres,
characterised in that
the method comprises pre-treatment of fibre material in a through-flow mixer operating on the principle of an impact mill, consisting of
- several, more typically 3 - 8, most typically 4 - 6, coaxial rings equipped with blades, of which at least every other ring operates as a rotor, and their adjacent rings either as stators or rotors, the difference in speed between the adjacent rings being 10 - 500 m/s, typically 50 - 200 m/s,
- feeding devices for supplying the fibre material predominantly to the centre of the said rings and
- an open, outermost ring, which allows the fibre suspension having flowed radially outward through the rings to be discharged from the ring in different directions, or an open outermost ring, equipped with one or several discharge openings for removing the fibre suspension having flowed radially outwards through the rings from the precipitation reactor.

24. Method according to claim 23, characterised in that
activation is advantageously performed when the fibres are swollen due to the addition of, $Ca(OH)_2$, for example.

25. Apparatuses to pretreat the fibre material to be used in manufacturing paper, paperboard or the like for activating the fibres and their surfaces, for example, so that their ability to bind with each other either mechanically or chemically increases, their ability to bind mineral substances either mechanically or chemically increases, active OH-groups are formed on their surfaces and/or their lumen opens up to allow mineral substances to precipitate inside the fibres,
characterised in that
the devices to pretreat fibre material comprise a through-flow mixer operating on the principle of an impact mill, consisting of
- several, more typically 3 - 8, most typically 4 - 6, coaxial rings equipped with blades, of which at least every other ring operates as a rotor and their adjacent rings either as stators or rotors, the difference in speed between the adjacent rings being 10 - 500 m/s, typically 50 - 200 m/s,
- feeding devices for supplying the fibre material mainly to the centre of the said rings and
- an open, outermost ring, which allows the fibre suspension having flowed radially outwards through the rings to be discharged from the ring in different directions, or an open, outermost ring, which is equipped with one or several discharge openings for removing the fibre suspension having flowed radially outwards through the rings from the precipitation reactor.

26. The use of the apparatus presented in claim 25 for pretreating the fibre material before it is brought into contact with the reactive mineral substance.